# Internet Addiction and Other Behavioral Addictions

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**KEYWORDS**

• Internet addiction • Internet gaming disorder • Compulsive internet use
• Behavioral addiction • Adolescence

**KEY POINTS**

- Teens are spending increasing amounts of time online. Although there are many benefits, there are also risks related to excessive use.
- Internet addiction is a type of behavioral addiction. Precise definitions vary and establishing clear diagnostic criteria is needed.
- It is important to recognize signs and symptoms of problematic Internet use and addiction including compulsive use, withdrawal, tolerance, and adverse consequences.
- Internet addiction is highly associated with depression, attention deficit hyperactivity disorder, and other substance use disorders. Treatment involves identifying and treating these comorbid conditions.
- More research is needed on targeted treatments for Internet addiction.

## INTRODUCTION

### *Behavioral Addiction*

Certain behaviors can produce short-term rewards or "highs." When this leads to diminished control over the behavior despite adverse consequences, the behavior itself can become the source of addiction rather than a psychoactive substance.[1–3]

Pathologic gambling is the best characterized behavioral addiction,[2,4] making a debut in the fifth version of the *Diagnostic and Statistical Manual of Mental Health Disorders* (DSM-5) under substance-related and addictive disorders.[5] Other behaviors that can produce similar short-term rewards include compulsive buying, sexual addiction, and excessive use of the Internet.[3,6,7] There is debate about which behaviors to include as behavioral addictions, because some may be better classified as impulse

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| Abbreviations | |
|---|---|
| ADHD | Attention deficit hyperactivity disorder |
| CBT | Cognitive–behavioral therapy |
| DSM | *Diagnostic and Statistical Manual of Mental Health Disorders* |
| IA | Internet addiction |

control disorders.[2,3] Growing evidence suggests that problematic Internet use should be conceptualized as a behavioral addiction.[8–12] Internet gaming disorder was identified in Section III of the DSM-5 as an area of future research[5] and is the next most likely candidate to join pathologic gambling as a behavioral addiction.

Behavioral addictions resemble substance use disorders in terms of phenomenology, natural history, and neurobiology.[3,13,14] The typical onset of behavioral addiction occurs in adolescence and young adulthood and follows a chronic course with remissions and exacerbations.[3] Adolescence is a developmentally vulnerable period for the initiation of addictive behavior, a time when social demands (increasingly online) are high, risk-taking behavior is expected, and novel situations are encouraged.[14]

### *Increasing Use and Misuse of the Internet*

The influence of the Internet is undeniable, particularly in the lives of young people. It is not surprising that time spent online is increasing. According to the most recent 2013 Youth Risk Behavior Survey, 41.3% of adolescents in the United States spent more than 3 hours online on school days for something that was not school work, increasing from 22% in 2003.[15] Online gaming is increasingly popular, notably massively multiplayer role-playing games or MMORGs.[16] Just as overall Internet use is increasing, problematic Internet use has become clinically concerning. There are a number of reports highlighting the negative consequences of overuse including problems with sleep, mood, and interpersonal relationships.[9,17–20] In some Asian countries, Internet addiction (IA) is considered a major public health issue.[21]

Many terms have been applied to this problem, including Internet gaming disorder, excessive Internet use, compulsive Internet use, problematic Internet usage, and pathologic Internet usage. For the purpose of this article, Internet Addiction (IA) will be used.

### *Aims*

The purpose of this paper is to review the current literature on the neurobiological underpinnings, epidemiology, clinical presentation, diagnosis, and treatment of IA in adolescence.

## NEUROBIOLOGY

The addictive process involves problems with aberrant reward systems and impulsivity.[14,22] Past research suggests that neural circuits in the brain involving reward get hijacked and rewired during the process of addiction.[14,23] Specifically, mesolimbic dopaminergic projections to the nucleus accumbens from the ventral tegmental area have been implicated.[14] Dopamine increases in the nucleus accumbens with the administration of drugs of abuse or certain behaviors (gaming, gambling, sexual behavior).[14] It has also been recognized that use of dopaminergic medication in Parkinson's patients can lead to pathologic gambling and other addictive behaviors such as binge eating and hypersexuality.[24]

Like other addictions, the development of behavioral addiction, including IA, is associated with an overall reward deficiency and involvement of these dopaminergic

pathways.[13,14] A PET study found striatal dopamine release in healthy volunteers during video game play.[25] Striatal dopamine receptor levels were reduced in men with IA compared with controls.[26] Kühn and colleagues[27] conducted an imaging study on 154 adolescents, comparing frequent and infrequent video game users. This study found higher volumes in left ventral striatum associated with frequent video game playing, which is consistent with findings of enhanced dopamine release during video game playing. A functional MRI study of addicted Internet gamers found that presenting cues of gaming elicited activation of right orbitofrontal cortex, right nucleus accumbens, right dorsolateral prefrontral cortex, and right caudate nucleus in contrast with the control group.[28] These findings support a similar neurobiological process to drug cravings for substance use disorders. Small gray matter structural changes in these pathways have also been implicated in adolescents with IA.[29,30] IA is also characterized by reward deficiency, specifically with diminished activity of ventral medial prefrontal cortex and involvement of dopaminergic mesolimbic pathways.[31]

Substance use disorders are known to run in families, with genes and temperament as well as early life experiences being important mediators.[14] Dopamine polymorphisms have previously been implicated in alcoholism and pathologic gambling. Han and colleagues[32] identified 2 genetic polymorphisms in dopamine genes that were more likely to be present in adolescents who were excessive video gamers compared with age-matched control subjects. Adolescents diagnosed with problematic Internet use in South Korea (compared with healthy control subjects) were found to be more likely to have anomalies in serotonin transporter genes.[33]

Poor behavioral inhibition or impulsivity leads to an emphasis on short-term consequences without consideration for longer term consequences. In IA, there is a tendency to discount rewards rapidly and perform poorly on decision making tests.[34–36] Individuals with IA are more likely to have high trait impulsivity.[35,37] Functional MRI studies on inhibitory tasks suggest impaired recruitment of frontal cortical projections.[38]

## PREVALENCE

Prevalence estimates of IA vary owing to methodologic differences and a lack of consensus diagnostically as well as the contribution of regional/cultural differences. Surveys in the United States and European countries suggest a range of prevalence between 1.5% and 8.2%.[11] The incidence of problematic Internet use in a large young European sample (11,356 adolescents in 11 European countries) found a prevalence of 4.4%, which was higher in males who preferred online gaming than females who preferred social networking.[39] Siomos and colleagues[40] found 8.2% of Greek adolescents to have IA whereas Bakken and colleagues[41] found the prevalence of IA to be 1% across the lifespan, with 3% to 4% prevalence rates in young men in Norway. Data from Germany suggest a prevalence of 1.5% to 3.5% of IA in adolescents.[42]

The prevalence of IA seems to be higher in Asian countries (specifically China, Taiwan, and South Korea), but it is unclear why. Yen and colleagues[43] identified the rate of IA to be 17.9% in Chinese high schoolers and 12.3% in college students.[44] The largest study in Taiwan (n = 9405) found that 18.8% of teenagers met IA criteria using Chen Internet Addiction Scale.[45] In a subsequent study by Ko and colleagues[46] in Taiwan, a lower rate of 10.8% was identified. Lam and colleagues[47] found that 10.8% of 13- to 18–year-olds in China were severely addicted to the Internet using the Internet Addiction Test. Park and colleagues[48] found that 10.7% of adolescents in Korea had IA. Ni and colleagues[49] identified a rate of 6.4% first year college students in China. In Hong Kong, the prevalence was identified to be 6.7% using Young's criteria and clinical interviews.[50]

### *Risk Factors*

Studies consistently show that males are more likely to become Internet addicted than females.[7,33,37,39,40,43,46] Online gaming is the most common source of IA.[40,51] However, both online gaming and use of social networking sites have been associated with increased risk for IA.[52,53]

In a recent study comparing problematic Internet use between gamers and nongamers among high school students, there were some notable differences: gamers with problematic Internet use were more likely to be male and have peer relation problems, whereas female Internet users were more likely to be nongamers.[54] There was a higher risk of depression in the non-gamers. Both groups showed elevated levels of psychopathology (depression, conduct disorder, attention deficit hyperactivity disorder [ADHD]) and more self-harming behavior compared with typical Internet users.[54]

Environmental risk factors include access to computer availability with Internet capability. Increasing time spent online is correlated with development of IA.[9,50,52,55] Family dysfunction and conflict as well as low family monitoring are frequently cited as contributors for IA.[48,56,57] Female adolescents may be at greater risk for the contribution of family factors to the development of IA.[56]

Various studies have identified several personality risk factors for IA. These factors include high exploratory excitability, low reward dependence, sensation seeking, and hostility, as well as low self-esteem and loneliness.[3,37,43,52,58,59]

One large survey based study in South Korea suggests that substance abuse often precedes IA, specifically smoking and drug use.[33] There is also some evidence to suggest that those with preexisting mental health conditions are more vulnerable to IA. In a prospective study, hostility in males and ADHD in females were the most significant predictors of development of IA.[46]

Little is known about prognosis in IA. In a 1-year prospective study, low hostility and low interpersonal sensitivity predicted remission of IA.[60]

### *Comorbidity*

High rates of psychiatric comorbidity can make it difficult to tease out the contribution of IA from other psychiatric conditions. Depression and ADHD are the most commonly cited comorbidities throughout the literature.[11,61–67] Social anxiety has also been reported.[43,61–63,65] Yen and associates[65] found that more severe psychiatric symptoms were associated with IA compared with other substance use disorders. A variety of substance use disorders have been associated with IA, including harmful alcohol use.[57,68] Other psychiatric disorders like bipolar disorder and various personality disorders have been reported in association with IA in adults.[61]

## CLINICAL PRESENTATION

**Clinical Vignette**

*James is a 16-year-old boy who spends most of his time online. He struggles to make it to school and has missed many days. He has a tendency to procrastinate and supposedly does "homework" online while actually gaming instead. He spends more than 5 hours online on school nights and goes to bed around 2 AM. This has led to increasing conflict at home. Of note, James has been diagnosed with major depression and social anxiety disorder.*

Compulsive use, tolerance, withdrawal, and diminished control despite adverse consequences currently define addictive disorders in DSM-5.[5] In keeping with this definition of addiction, there are several key features of IA.

1. The first is preoccupation with the Internet. More than 20 hours a week is consistent with prolonged Internet use.[9,69,70]
2. Next is spending time for longer amounts than originally intended and needing more time to achieve satisfaction (tolerance).
3. Some teens may develop mood symptoms (agitation/irritability/depression) when limits are set on use of the Internet, consistent with withdrawal.
4. It becomes difficult to manage the amount of time spent online (diminished control).

In addition, there must be evidence of functional impairment or adverse consequences as a result of excessive Internet use. Normal obligations are neglected. Commonly, this manifests as sleep deprivation with excessive daytime sleepiness,[17] school or work avoidance, worsening depression, social isolation, and family conflict.[8,9,11] It is extremely worrisome when time spent on the Internet interferes with food and water intake or neglect of hygiene.[9] Hand and wrist pain as well as back and eye strain may also develop as a result of IA.[9]

Some research suggests that those with IA are more likely to develop depression later in life.[71] IA has also been associated with aggression, suicidal ideation, and self-harm.[45,63,66,67] Full psychiatric diagnostic assessment is important, because comorbid depressive and anxiety disorders are common, as well as ADHD.[63] The differential diagnoses include mood disorders, anxiety disorders, and ADHD as the primary drivers of excessive Internet use, rather than a separate addictive disorder. It is also important to distinguish IA from normal Internet use.

## ASSESSMENT

Young was the first to define IA in clinical terms, developing the Young Diagnostic Questionnaire and the Internet Addiction Test.[11] Young defines IA by the presence of 5 or more items out of 8 endorsed regarding Internet use: preoccupation, tolerance, withdrawal, failure to control, more use than intended, functional impairment, lying about use, and use to escape a dysphoric mood.[11] The Internet Addiction Test consists of 20 questions about Internet use that are answered on a 5-point scale, ranging from rarely to often. A score of 80 or greater is clinically significant for problematic Internet use.[11] The Internet Addiction Test has been well-validated.[8,72,73] The Chen Internet Addiction Scale is another tool for IA and is a self-report measure consisting of 26 questions with ratings on a 4-point Likert scale with a cutoff score of 64 or more suggestive of problematic Internet use. The Chen Internet Addiction Scale assesses for compulsive use, withdrawal, tolerance, and negative adverse consequences of use and also has been well-validated.[8,73]

## DIAGNOSIS

The proposed criteria for Internet gaming disorder in DSM-5 include:

a. Preoccupation with Internet games (individual thinks about previous gaming activity or anticipates playing the next game; Internet gaming becomes the predominant activity in daily life);
b. Withdrawal symptoms when the Internet is taken away (typically irritability, anxiety, sadness);

c. Tolerance (the need to spend increasing amounts of time on Internet games to achieve the same "high");
d. Unsuccessful attempts to control or cut down the participation in Internet games;
e. Loss of interest in previously enjoyable activities with the exception of Internet gaming;
f. Continued excessive use despite knowledge of negative psychosocial problems;
g. Has deceived family members, therapists, or others regarding time spent on gaming;
h. Use of Internet games to escape or improve dysphoric mood; and
i. Jeopardized or lost relationships, jobs, educational opportunities because of Internet use.

The presence of 5 or more of these symptoms in the past 12 months in combination with persistent, maladaptive, and recurrent use of the Internet is required.[5]

However, Internet gaming disorder does not encompass all forms of problematic Internet use. Other online activities have a similar addictive potential. In a longitudinal study of 447 heavy Internet users, online gaming and sexual activities were most highly associated with problematic Internet use.[51] Other studies suggest that social media interfaces are also important sources of IA, particularly in females.[53,54,74]

Although controversy remains on this topic, there is some evidence that the same criteria for addiction can be applied to other uses of the Internet.[31,53,54] Specific diagnostic criteria of IA in adolescence was explored by Ko and colleagues[69] who proposed that there are 9 characteristic symptoms: preoccupation, uncontrolled impulse, more use than intended, tolerance, withdrawal, impairment of control, excessive time and effort spent online, and impaired decision making. Next, there must be evidence of functional impairment, namely, failure to fulfill role obligations at school and home and/or impaired social relationships.[69,70] Other definitions draw from pathologic gambling criteria and/or substance dependence criteria.[11] Unfortunately, more nosologic precision is needed.

## CLINICAL MANAGEMENT

There is growing demand for evidence-based recommendations for the treatment of IA. Treatment for IA is currently largely based on interventions and strategies used in substance use disorders. The goal in any addiction treatment is to modify neurobiological as well as psychosocial risk factors in combination with limiting exposure or access to a substance or behavior.[3,11,14]

### *Comorbidity*

The first step in clinical management of IA is a careful assessment of comorbid psychiatric disorders. Comorbid disorders should be treated to prevent their deteriorating effect on the prognosis of IA. In particular, effective evaluation and treatment of ADHD and depression is imperative.[46,60,75] Ongoing attention to hostility and aggression, especially in males, is relevant given the association with IA.[43] Prevention of IA in turn may improve treatment of preexisting depression, which can be exacerbated by spending excessive time online.[71]

### *Prevention*

Early screening and prevention of IA could be effective but has not been tested.[71] Some practical tips for parents include:

1. Encourage other interests and activities that do not involve the Internet. Team sports and after school clubs can promote healthy face-to-face peer interactions.

2. Set clear limits on time spent online (<2 hours per night). Restrict use of the computer to a common area so you can monitor online activity. Consider various apps to help limit use of the Internet through smartphones (limiting data usage, restricting texting and web browsing to certain times of day). Model appropriate use of the Internet yourself.
3. Talk to your teen about stressors in their life. Consider the role of anxiety or depression. Seek professional help if there are concerns about mood.

### *Psychosocial Interventions*

Winkler and colleagues[76] conducted a metaanalysis of IA treatment in 2013. This study suggests effective psychological interventions exist in targeting IA directly (effect size = 1.61), as well as decreasing time spent online (effect size = 0.94), depression (effect size = 0.90), and anxiety (effect size = 1.25). These results need to remain preliminary owing to the number of studies and methodologic limitations. Another review of treatment of IA by King and colleagues[77] was less optimistic about recommending treatment owing to a lack of diagnostic and methodologic consistency (absence of controls and objective outcomes) throughout studies.

Several studies suggest that cognitive–behavioral therapy (CBT) and other psychosocial interventions can be effective at reducing time spent online and reducing depressive symptoms.[8,14,42,76–79] CBT-IA has been created by Young[78] to target IA specifically and preliminary results in adults are encouraging. The intervention focuses on monitoring of behavior (keeping a log of Internet activity), teaching time management skills, goal setting, and restructuring cognitive distortions. One small pilot study of online pornography addiction with acceptance commitment therapy showed promising results.[80] Teaching coping skills around distress tolerance (or frustration intolerance) may be useful, but targeted studies are lacking.[81]

Other psychosocial treatments include 12-step self-help approaches and motivational enhancement.[7] These interventions rely on a relapse prevention model to reduce IA, including avoiding or coping with high-risk situations.[7,10,11] Support groups are not well-defined for IA compared with other addictions, particularly not support groups found online.[8] Motivation to change addictive behaviors is often low in adolescents and parents may be the ones presenting with concerns. However, certain motivational enhancement strategies can be useful, for example, helping teens to recognize what important activities or values are being neglected because of time spent online and careful consideration of the pros and cons of online use.[46] A multilevel counseling center in Hong Kong (incorporating elements of motivational enhancement, CBT, and family interventions) was effective in reducing IA symptoms in a group of 59 individuals, mainly adolescents.[82] Orzack and colleagues[83] combined features of CBT and motivation enhancement in a 16 week group treatment of cybersex IA for adults, which resulted in reduced depressive symptoms and improved quality of life but no change in sexual behavior.

A family-based approach makes sense in light of the familial risk factors associated with IA. Specifically, Ko and colleagues[56] found that reducing interparental conflict and promoting family function and Internet regulation were helpful in preventing IA. Reducing family conflict and improving communication are natural targets of treatment.[84] Furthermore, families play an important role in limiting access to excessive Internet usage.[46]

### *Pharmacotherapy*

No medications have been approved for treatment of behavioral addictions, but some show promise for IA like bupropion and methylphenidate.[76] Bupropion was helpful in

reducing cravings and severity of IA in a small study of 11 men and also modified cue-induced brain activity.[85] Another study by Han and colleagues[86] showed that treatment with methylphenidate in drug-naïve ADHD kids helped to reduce time spent on the Internet. Escitalopram has been studied in a small open label trial of 19 subjects, with no significant difference reported.[87]

## SUMMARY

Although the Internet remains a powerful and positive force in the lives of many, a minority of users may become addicted. This is of particular concern for adolescents, because they are spending increasing amounts of time online and they are uniquely vulnerable to the development of addictive behavior.

IA is a type of behavioral addiction that resembles substance use disorders in phenomenology and neurobiology. Although this disorder has received attention from both scientists and the media, formal consensus on diagnostic criteria for IA is lacking. The repercussions of excessive Internet use are clear and impairing, ranging from sleep deprivation to worsening depression to school avoidance to family conflict. There are high rates of comorbid depression, anxiety, ADHD, and other substance use disorders. Other risk factors include various personality traits (notably impulsivity, hostility, sensation seeking), family conflict, low parental monitoring, and male gender. At this point, clinical management of IA includes treatment of comorbid conditions, CBT, motivational enhancement, family work, and some very preliminary pharmacologic studies. Further research is certainly indicated to better clarify formal diagnosis and treatment.

## REFERENCES

1. Holden C. Behavioral addictions debut in proposed DSM-V. Science 2010; 327(5968):935.
2. Potenza MN. Should addictive disorders include non-substance-related conditions? Addiction 2006;101(1):142–51.
3. Grant JE, Potenza MN, Weinstein A, et al. Introduction to behavioral addictions. Am J Drug Alcohol Abuse 2010;36(5):233–41.
4. Clark L, Limbrick-Olfield EH. Disordered gambling: a behavioral addiction. Curr Opin Neurobiol 2013;23(4):655–9.
5. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th edition. Washington, DC: American Psychiatric Association; 2013.
6. Robbins TW, Clark L. Behavioral addictions. Curr Opin Neurobiol 2015;30:66–72.
7. Brezing C, Derevensky JL, Potenza MN. Non-substance addictive behaviors in youth: pathological gambling and problematic internet use. Child Adolesc Psychiatr Clin N Am 2010;19(3):625–41.
8. Aboujaoude E. Problematic internet use: an overview. World Psychiatry 2010; 9(2):85–90.
9. Young KS. Internet addiction: the emergence of a new clinical disorder. Cyberpsychol Behav 1998;1(3):237–44.
10. Shaw M, Black DW. Internet addiction: definition, assessment, epidemiology and clinical management. CNS Drugs 2008;22(5):353–65.
11. Weinstein A, Lejoyeux M. Internet addiction or excessive internet use. Am J Drug Alcohol Abuse 2010;36(5):277–83.
12. Spada MM. An overview of problematic internet use. Addict Behav 2014;39(1): 3–6.

13. Kuss DJ, Griffiths MD. Internet and gaming addiction: a systematic literature review of neuroimaging studies. Brain Sci 2012;2(3):347–74.
14. Hammond CJ, Mayes LC, Potenza MN. Neurobiology of adolescent substance use and addictive behaviors: prevention and treatment implications. Adolesc Med State Art Rev 2014;25(1):15–32.
15. Kann L, Kinchen S, Shanklin SL, et al. Youth risk behavior surveillance—United States, 2013. MMWR Surveill Summ 2014;63(4):1–168.
16. Kuss DJ, Louws J, Wiers RW. Online gaming addiction? Motives predict addictive play behavior in massively multiplayer online role-playing games. Cyberpsychol Behav Soc Netw 2012;15(9):480–5.
17. Choi K, Son H, Park M, et al. Internet overuse and excessive daytime sleepiness in adolescents. Psychiatry Clin Neuroci 2009;23(4):455–62.
18. Milani L, Osualdella D, Di Blasio P. Quality of interpersonal relationships and problematic internet use in adolescents. Cyberpsychol Behav 2009;12(6):681–4.
19. Nalwa K, Anand AP. Internet addiction in students: a cause for concern. Cyberpsychol Behav 2003;6(6):653–6.
20. Christakis DA, Moreno MA. Trapped in the net: will internet addiction become a 21st century epidemic? Arch Pediatr Adolesc Med 2009;163(10):959–60.
21. Stewart CS. Obsessed with the internet: a tale from China. 2010. Available at: http://www.wired.com/2010/01/ff_Internetaddiction/. Accessed October 18, 2015.
22. Goodman A. Neurobiology of addiction: an integrative review. Biochem Pharmacol 2008;75(1):266–322.
23. Joffe ME, Greuter CA, Grueter BA. Biological substrates of addiction. Wiley Interdiscip Rev Cogn Sci 2014;5(2):151–71.
24. Dagher A, Robbins TW. Personality, addiction, dopamine: insights from Parkinson's disease. Neuron 2009;61:502–10.
25. Koepp MJ, Gunn RN, Lawrence AD, et al. Evidence for striatal dopamine release during a video game. Nature 1998;393(6682):266–8.
26. Kim SH, Baik SH, Park CS, et al. Reduced striatal dopamine D2 receptors in people with internet addiction. Neuroreport 2011;22(8):407–11.
27. Kühn S, Romanowski A, Schilling C, et al. The neural basis of video gaming. Transl Psychiatry 2011;1:e53.
28. Ko CH, Lin GC, Hsiao S, et al. Brain activities associated with gaming urge of online gaming addiction. J Psychiatr Res 2009;43(7):739–47.
29. Yuan K, Qin W, Wang G, et al. Microstructure abnormalities in adolescents with internet addiction disorder. PLoS One 2011;6(6):e20708.
30. Zhou Y, Lin FC, Du YS, et al. Gray matter abnormalities in internet addiction: a voxel based morphometry study. Eur J Radiol 2011;79(1):92–5.
31. Brand M, Young KS, Laier C. Prefrontal control and internet addiction: a theoretical model and review of neuropsychological and neuroimaging findings. Front Hum Neurosci 2014;8:375.
32. Han DH, Lee YS, Yang KC, et al. Dopamine genes and reward dependence in adolescents with excessive internet video game play. J Addict Med 2007;1(3):133–8.
33. Lee YS, Han DH, Kim SM, et al. Substance abuse precedes internet addiction. Addict Behav 2013;38(4):2022–5.
34. Irvine MA, Worbe Y, Bolton S, et al. Impaired decisional impulsivity in pathological videogamers. PLoS One 2013;8(10):e75914.
35. Little M, van den Berg I, Luijten M, et al. Error processing and response inhibition in excessive computer game players: an event-related potential study. Addict Biol 2012;17(5):934–47.

36. Sun DL, Chen ZJ, Ma N, et al. Decision making and prepotent response inhibition functions in excessive internet users. CNS Spectr 2009;14(2):75–81.
37. Munno D, Saoldi M, Bechon E, et al. Addictive behaviors and personality traits in adolescents. CNS Spectr 2015;13:1–7.
38. Dong G, Hu Y, Lin X, et al. What makes internet addicts continue playing online even when faced by severe negative consequences? Possible explanations from an fMRI study. Biol Psychol 2013;94(2):282–9.
39. Durkee T, Kaess M, Carli V, et al. Prevalence of pathological internet use among adolescents in Europe: demographic and social factors. Addiction 2012;107(12): 2210–22.
40. Siomos KE, Dafouli ED, Braimiotis DA, et al. Internet addiction among Greek adolescent students. Cyberpsychol Behav 2008;11(6):653–7.
41. Bakken IJ, Wenzel HG, Gotestam KG, et al. Internet addiction among Norwegian adults: a stratified probability sample study. Scand J Psychol 2009;50(2):121–7.
42. Peukert P, Sieslack S, Barth G, et al. Internet and computer game addiction: phenomenology, comorbidity, etiology, diagnostics and therapeutic implications for the addicts and their relatives. Psychiatr Prax 2010;37(5):219–24.
43. Yen JY, Ko CH, Yen CF, et al. The comorbid psychiatric symptoms of internet addiction: attention deficit and hyperactivity disorder (ADHD), depression, social phobia, and hostility. J Adolesc Health 2007;41(1):93–8.
44. Yen JY, Yen CF, Chen CS, et al. The association between adult ADHD symptoms and internet addiction among college students: the gender difference. Cyberpsychol Behav 2009;12(2):187–91.
45. Ko CH, Yen JY, Liu SC, et al. The associations between aggressive behaviors and internet addiction and online activities in adolescents. J Adolesc Health 2009; 44(6):598–605.
46. Ko CH, Yen JJ, Chen CS, et al. Predictive values of psychiatric symptoms for internet addiction in adolescents: a 2 year prospective study. Arch Pediatr Adolesc Med 2009;163(10):937–43.
47. Lam LT, Peng ZW, Mai JC, et al. Factors associated with internet addiction among adolescents. Cyberpsychol Behav 2009;12(5):551–5.
48. Park SK, Kim JY, Cho CB. Prevalence of internet addiction and correlations with family factors among South Korean adolescents. Adolescence 2008;43(172): 895–909.
49. Ni X, Yan H, Chen S, et al. Factors influencing internet addiction in a sample of Freshman University students in China. Cyberpsychol Behav 2009;12(3):327–30.
50. Fu KW, Chan WS, Wong PW, et al. Internet addiction: prevalence, discriminant validity and correlates among adolescents in Hong Kong. Br J Psychiatry 2010;196(6):486–92.
51. Meerkerk GJ, Van Den Eijnden RJ, Garretsen HF. Predicting compulsive internet use: it's all about sex! Cyberpsychol Behav 2006;9(1):95–103.
52. Kuss DJ, Griffiths MD, Binder JF. Internet addiction in students: prevalence and risk factors. Comput Hum Behav 2013;29(3):959–66.
53. Kuss DJ, Griffiths MD. Online social networking and addiction – a review of the psychological literature. Int J Environ Res Public Health 2011;8(9):3528–52.
54. Strittmater E, Kaess M, Parzer P, et al. Pathological internet use among adolescents: comparing gamers and non-gamers. Psychiatry Res 2015;228(1):128–35.
55. Chou WJ, Liu TL, Yang P, et al. Multi-dimensional correlates of internet addiction symptoms in adolescents with attention-deficit/hyperactivity disorder. Psychiatry Res 2015;225(1–2):122–8.

56. Ko CH, Wang PW, Liu TL, et al. Bidirectional associations between family factors and internet addiction among adolescents in a prospective investigation. Psychiatry Clin Neurosci 2015;69(4):192–200.
57. Lam LT. Risk factors of internet addiction and the health effect of internet addiction on adolescents: a systematic review of longitudinal and prospective studies. Curr Psychiatry Rep 2014;16(11):508.
58. Gentile D. Pathological video game use among youths: a two-year longitudinal study. Pediatrics 2011;127(2):319–29.
59. Mehroof M, Griffiths MD. Online gaming addiction: the role of sensation seeking, self-control, neuroticism, aggression, state anxiety, and trait anxiety. Cyberpsychol Behav 2010;13(3):313–6.
60. Ko CH, Yen JY, Yen CF, et al. Factors predictive for incidence and remission of internet addiction in young adolescents: a prospective study. Cyberpsychol Behav 2007;10(4):545–51.
61. Bernardi S, Pallanti S. Internet addiction: a descriptive clinical study focusing on comorbidities and dissosociative symptoms. Compr Psychiatry 2009;50(6):510–6.
62. Carli V, Durkee T, Wasserman D, et al. The association between pathological internet use and comorbid psychopathology: a systematic review. Psychopathology 2013;46(1):1–13.
63. Ko CH, Yen JY, Yen CF, et al. The association between internet addiction and psychiatric disorders: a review of the literature. Eur Psychiatry 2012;27(1):1–8.
64. Yen JY, Ko CH, Yen CF, et al. Psychiatric symptoms in adolescents with internet addiction: comparison with substance use. Psychiatry Clin Neurosci 2008;62(1):9–16.
65. Yen CF, Chou WJ, Liu TL, et al. The association of internet addiction symptoms with anxiety, depression and self-esteem among adolescents with attention-deficit/hyperactivity disorder. Compr Psychiatry 2014;55(7):1601–8.
66. Lin IH, Ko CH, Chang YP, et al. The association between suicidality and internet addiction and activities in Taiwanese adolescents. Compr Psychiatry 2014;55(3):504–10.
67. Kim K, Ryu E, Chon MY, et al. Internet addiction in Korean adolescents and its relation to depression and suicidal ideation: a questionnaire survey. Int J Nurs Stud 2006;43(2):185–92.
68. Yen JY, Ko CH, Yen CF, et al. The association between harmful alcohol use and internet addiction among college students: comparison of personality. Psychiatry Clin Neurosci 2009;63(2):218–97.
69. Ko CH, Yen JY, Chen CC, et al. Proposed diagnostic criteria of internet addiction for adolescents. J Nerv Ment Dis 2005;193:728–33.
70. Ko CH, Yen JY, Chen SH, et al. Proposed diagnostic criteria and the screening and diagnosing tool of internet addiction in college students. Compr Psychiatry 2009;50(4):378–84.
71. Lam LT, Peng ZW. Effect of pathological use of the internet on adolescent mental health: a prospective study. Arch Pediatr Adolesc Med 2010;164(10):901–90.
72. Widyanto L, Griffiths MD, Brunsden V. A psychometric comparison of the internet addiction test, the internet-related problem scale, and self-diagnosis. Cyberpsychol Behav Soc Netw 2011;14(3):141–9.
73. Beard KW. Internet addiction: a review of current assessment techniques and potential assessment questions. Cyberpsychol Behav 2005;8(1):7–14.

74. Van Rooij AJ, Schoenmakers TM, van de Eijnden RJ, et al. Compulsive internet use: the role of online gaming and other internet applications. J Adolesc Health 2010;47(1):51–7.
75. Ko CH, Liu TL, Wang PW, et al. The exacerbation of depression, hostility, and social anxiety in the course of internet addiction among adolescents: a prospective study. Compr Psychiatry 2014;55(6):1377–84.
76. Winkler A, Dorsey B, Rief W, et al. Treatment of internet addiction: a meta-analysis. Clin Psychol Rev 2013;33(2):317–29.
77. King DL, Delfabbro PH, Griffiths MD, et al. Assessing clinical trials of internet addiction treatment: a systematic review and CONSORT evaluation. Clin Psychol Rev 2011;31(7):1110–6.
78. Young KS. Cognitive behavior therapy with internet addicts: treatment outcomes and implications. Cyberpsychol Behav 2007;10(5):671–9.
79. Du YS, Jiang W, Vance A. Longer term effect of randomized, controlled group cognitive behavioural therapy for internet addiction in adolescent students in Shanghai. Aust N Z J Psychiatry 2010;44(2):129–34.
80. Twohig MP, Crosby JM. Acceptance and commitment therapy as a treatment for problematic internet pornography viewing. Behav Ther 2010;41(3):285–95.
81. Ko CH, Yen JY, Yen CF, et al. The association between internet addiction and belief of frustration intolerance: the gender difference. Cyberpsychol Behav 2008;11(3):273–8.
82. Shek DT, Tang VM, Lo CY. Evaluation of an internet addiction treatment program for Chinese adolescents in Hong Kong. Adolescence 2009;44(174):359–73.
83. Orzack MH, Voluse AC, Wolf D, et al. An ongoing study of group treatment for men involved in problematic internet-enabled sexual behavior. Cyberpsychol Behav 2006;9(3):348–60.
84. Yen JY, Yen CF, Chen CC, et al. Family factors of internet addiction and substance use experience in Taiwanese adolescents. Cyberpsychol Behav 2007;10(3):323–9.
85. Han DH, Hwang JW, Renshaw PF. Bupropion sustained release treatment decreases craving for video games and cue-induced brain activity in patients with internet video game addiction. Exp Clin Psychopharmacol 2010;18(4):297–304.
86. Han DH, Lee YS, Na C, et al. The effect of methylphenidate on internet video game play in children with attention-deficit/hyperactivity disorder. Compr Psychiatry 2009;50(3):251–6.
87. Hadley SJ, Baker BR, Hollander E. Efficacy of escitalopram in the treatment of compulsive-impulsive computer use disorder. Biol Psychiatry 2006;69(3):452–6.